50X1-HUM

Next 2 Page(s) In Document Denied

THE PRINCIPAL TRENDS IN SCIENTIFIC RESEARCHES IN THE FIELD OF THE STRENGTH AND STRUCTURE OF MERCHANT SHIPS IN THE USSR

During the last few years the principal scientific research work in the USSR on the ship strength and structure was directed towards the solution of the following two interconnected problems:

a) The improvement of the existing Rules of the Register of Shipping of the USSR for classification and construction of seagoing steel vessels.

b) A further development of the calculation method in determining the scantlings of the structure of merchant ships.

The object of the first problem is:

To supplement the Rules in force with new data regulating more precisely the relationship between loading and scantlings of the hull structure, ensuring a more rational use of hull steel.

In 1956 the Register of Shipping of the USSR reissued rules for the classification and the construction of seagoing steel ships which were supplemented in 1958 and 1959 with the two chapters prescribing: the first — supplementary requirements about scantlings of structures of ore carriers and the second — provisions to take into account peculiarities of a general arrangement and shape of the hull. At present a new edition of these Rules is in preparation for publication. The results of the latest scientific researches during the mentioned period will be taken into account as well as the experience gained in regard to the construction and navigation of ships built in conformity with the Rules.

In the new edition of the Rules an estimate of the scantlings of all principal structures of the hull is envisaged depending on the value of the loading that is assumed can be encountered by ships during the navigation, thus taking into consideration individual peculiarities of ships. Essential amendments and additions based on the results of appropriate theoretical and experimental research works are being introduced. These amendments and additions will give the possibility to take into account such essential factors, which have not had enough consideration in the Rules at present in force, viz.:

1. Slamming.
2. The use of low alloy (high tensile) steel, aluminium alloys and other materials, taking into account their mechanical properties.
3. The use of corrugated bulkheads in hull construction.
4. Designing of multi-tier superstructures of complicated configuration.
5. Ice strengthenings of the hull structures in merchant ships and the structures of ice-breakers.

The new rules will contain essential data about constructive details of different hull members, chiefly intermittent ones, which can be a source of stress concentration, and also specific provisions as called forth by the widespread use of various types of welding in hull construction now exclusively used in the USSR instead of riveting.

It should be noted that in the USSR, and apparently abroad as well, the question of using riveted seams in welded hulls as barriers against the spreading of cracks still remains unsettled.

The opponents of such crack arresters consider that the use of steel, which in itself is capable to resist against the spreading of brittle fractures, excludes the necessity of using riveted seams.

In spite of the amendments introduced into the Rules of the Register of Shipping of the USSR, these rules, owing to their inherent deficiency, are not able to fully meet the requirements of rational designing of hulls of various types of merchant vessels.

The principal deficiency of the Rules is that they are essentially empirical and, while dealing with strength and the safety of the ships, do not give enough consideration to possibilities of reducing the weight of the hull, admitting in some cases an excessive margin of strength.

The above mentioned shows the necessity of further amendments of the Rules in force and simultaneously calls for the development of the calculation method in designing hulls of merchant vessels.

This method should be understood as a general process of determining scantlings of the main hull structure, ensuring general and local strength on the basis of the ship strength theory in conformity with the standards of loading and permissible stresses prescribed by the Register. Wear, the margin for the corrosion of the material used and other prescribed norms and regulations should also be taken into account. The scantlings of the hull girders and structures should be submitted to approval in an appropriate form in accordance with the special practice of hull designing.

"The Standards of Strength for Seagoing Steel Vessels" and a "Manual for the Calculation of the Strength of Seagoing Steel Vessels"

were published in the USSR in 1958. They are based on experience collected by that time in designing, construction and navigation of ships as well as on theoretical and experimental researches.

According to the general regulations in the first chapter of the "Standards of Strength for Seagoing Steel Vessels" theses standards are valid for vessels of 60 m. or more in length and shall be also used for the checking of the structure strength of vessels of 110 m in length and over, designed in accordance with the Rules for the classification and construction of seagoing steel vessels.

These "Standards" include special instructions for the calculations of the general strength of the hull allowing for the dynamic component of the bending moment. For this purpose corresponding rated formulae and diagrams are given. For the estimation of the margin of strength in the most unfavourable sea conditions, the strength calculations based on limiting moments shall be carried out. The term "limiting moment" denotes that under its action the stresses in one of the extreme laminas of the weakest sections in the middle part of the ship attain the yield point of the material accepted.

The "Standards" also include instructions for the setting of rated loadings and norms of permissible stresses as well as a selection of the design of ship sections and the definition of structural members to be included into the section modulus of the ship, an estimation of the width of the conjunctive plating to be taken into account in the local strength of ship's members, a reduction of the plates' sectional area if they can be buckled under the action of compressive forces, as well as other provisions. "Standards of Strength" published in 1958 enabled us to put into practical use the calculation method for the designing of ship structures. The theoretical and experimental study carried out since that time in the field of external forces acting on a ship's hull in rough seas, more precise methods of calculation, the analysis of navigational and service data as well as the experience gained in applying the "Standards of Strength" in the last three years had made necessary their amendments and additions.

The "Standards of Strength" have recently been revised and a new edition is in preparation. To this end the scientific research has been carried out along the following lines:

I. A more precise estimation of the general bending forces acting on ships.

II. A study of internal stresses arising in the structure of hulls and working out of more precise methods of their calculation.

III. A revision of the coefficients of the margin of strength.

IV. The working out of other guiding instructions for the calculation of structures of merchant vessels.

A MORE PRECISE ESTIMATION OF THE GENERAL BENDING FORCES ACTING ON SHIPS

A more precise estimation of the general bending forces acting on ships is primarily connected with a manifold study of external loading acting on the ship's hull in rough seas. This is studied both theoretically and experimentally. The said field of knowledge presents special difficulties for investigation.

A number of views exists, and each has its own followers. During the past few years attempts were made to apply the theory of stationary accidental processes and statistical dynamics to the problem of external forces, acting on the ship in irregular waves at sea.

Some works on the said subject suggest the evaluation of strength based on the examination of the probable collapse of a structure under the action of loading instead of on the basis of permissible stresses. A number of Soviet authors who do not share the expediency of using the apparatus of accidental functions for practical methods of calculation, devote their investigations to the matter of using statistical methods for establishing relationships between the height and the length of the rated waves as well as the establishment of necessary margins of strength.

Summarizing the researches carried out in the USSR and abroad it became possible to establish the length to height ratios of the waves which should form the basis of calculations of the longitudinal strength of ships.

In studying external forces much attention has been given to slamming.

The problem of ensuring a greater strength of the hull against slamming is very important, especially nowadays, because of the growing tendency of increasing speed of merchant ships in high seas. This can be seen, in the first instance, from the increasing number of experimental and theoretical researches devoted to this problem during the past few years, both in the USSR and abroad, and secondly, from the fact that foreign classification societies (for instance the British Lloyd's Register of Shipping) found it necessary to add to the Rules a clause stipulating a special increase in thickness of the strength deck reckoning with the effect of slamming.

The measurements of stresses in hull members at the instants of slamming in heavy seas show that the frequency of flexural vibrations of the hull due to slamming are close to the ship's natural frequency of the first mode stresses in the main structures of the hull due to this vibration and are added to the stresses caused by the general bend of the hull itself when the ship sails in a rough sea.

As a result of theoretical and experimental researches the general effect of slamming in heavy seas was studied, and a practical method was proposed for the computation of the design values of external forces when checking the general and the local strengths of ships' hulls in a rough sea.

Simultaneously with theoretical investigations model tests in model basins as well as special trials of ships are conducted in order to ascertain the behaviour of sbips' structures in heavy seas. The model proposed by E. Lewis (with a cut into which resilient materials are put in) as well as other models (patented in the USSR) have been tested. In particular, a model consisting of a large number of compartments fastened to a resilient beam modelling the rigidity of the hull has also been tested. These researches as well as tests of ships at sea proved the incompetence of the hypothesis that the pressure at each point of the submerged surface of the vessel would be equal to the pressure in the corresponding point in the mass of water under the wave surface. The effect of the hull on the structure of waves was found very essential, especially in regard to ships having a comparatively big breadth.

Extensive strength tests were carried out on a diesel-electric dry-cargo ship of 5000 tons carrying capacity in the Atlantic Ocean in the winter and spring of 1961. Numerous measurements were taken of stresses due to the general longitudinal bending and to the vibration following slamming. The impacts of hydrodynamic pressures against the bowpart of the ship were also recorded. These tests will be resumed and continued this autumn.

A STUDY OF INTERNAL STRESSES ARISING IN THE STRUCTURE OF HULLS AND WORKING OUT OF MORE PRECISE METHODS OF THEIR CALCULATIONS

1. Hull damages made the shipbuilders in many countries reckon with the effect of stress concentration and pay special attention to the correct designing of hull members at sections where sharp changes of their area take place.

In this connection in the USSR the work on the theory of strains of intermittent members of hull was developed, and it enabled shipbuilders to determine by this calculation method the coefficient of concentration at points of sharp changes of section areas at the ends of superstructures, large openings, etc.

2. In the USSR in connection with the constantly increasing construction of merchant ships with superstructures of complicated configuration and a variable rigidity along their length and with various openings and recesses, Soviet ship designers show a keen interest in the problem of strength calculations and the framing of such superstructures. A number of theoretical works on the subject was published, in which this problem was approached by means of applying the theory of intermittent members and the theory of elasticity.

Special attention is now being paid to the investigations of the stress distribution at the ends of superstructures and at the openings for doors and windows.

3. Much attention is given in the USSR to the question of carrying capacity of hull structure, which is connected with a study of plastic strains of material. This is naturally being studied as a whole, both theoretically and experimentally. Together with the development of the mathematical theory of elasticity, works on applied technical theory of plasticity are also carried on.

In order to estimate the carrying capacity of statically indeterminable structures, various methods have been worked out and further research work in this field is being conducted on different methods of calculation of combined effect of normal stresses, shearing forces, stretching, etc. In so far as the use of new building materials, such as aluminium alloys and such grades of steel which have no distinctly expressed yield point, it is necessary to reckon with the effect of self strengthening, a number of authors propose different methods enabling ship designers to formulate and solve differential equations defining the interdependence between stresses and strains in an elastic-plastic region. Besides the estimation of the carrying capacity of the structural members under the stress action, there appears a necessity of regulating general deflections of structures. These circumstances require the working out of practical formulae which would enable the designers to define the residual deflection of structures.

The scientific research in the above mentioned field made a noteworthy progress and found a practical application in the designing of icebreakers and the strengthening of ships' hulls for the navigation in ice conditions.

4. The question of the definition of the virtual width of the conjunctive plating of structure members subjected to compressive forces, bending and other kinds of loadings continue to draw the attention of scientific workers. Such factors as the degree of excessive active compressive forces in rigid members as compared with Euler stresses in plating, the initial plate deflection, if any, and its form, the transverse loading, the stretching effect of the framing, etc., are also considered in these researches.

5. In connection with the tendency to enlarge cargo hatchways, the stability under compressive forces of deck structures is being investigated in relation to this particular case.

6. To ensure the wide uses in hulls of corrugated bulkheads of a channel and wavy type, a complex theoretical and experimental research

was made with a view of establishing a practical method of calculation of strength and stability of corrugated bulkheads under various loading that may be encountered in the actual service of the ship. The said research permitted in the end to arrive at satisfactory solutions of all the vital questions.

7. Considerable attention is paid to the vibration of the hull and its structures.

A steady tendency to increase speed with a corresponding increase of the power of ship's main engines urgently required the working out of methods aiming at the elimination, as far as possible, of the vibrations of the hull and of ship's installations. The main trend in the scientific research in our country in this connection is given below:

Firstly, it is the study of the cause and nature of the existing forces and secondly — the study of the dynamic characteristics of the ship's hull and structures, as well as the use of vibration dampers of different types.

Investigations of vibration by means of calculations of separate ship structural members with due regard to dynamics constitute an important part of the conducted researches.

The importance of this part of the problem is well known and primarily consists in the fact that an increased local vibration can cause the appearance of a considerable number of fatigue cracks, i. e. a failure of strength of such important members of the hull as the shell and deck plating.

A study of local strength of structures which are subject to forces exciting vibration is being realized with due regard to various kinds of unlineal factors (chain stresses, clearances in structures and others), a work concerned with the physical nature and quantitative values of sources of damping as well as investigations of vibrations of hull girders for modes above the two node mode are being carried out.

It should be noted that along with the theoretical investigations of the ship's vibrations, serious attention is given to experiments. Tests, as a rule, are made in conjunction with some new theoretical contributions, and they are generally mutually complementary.

A REVISION OF THE COEFFICIENTS OF THE MARGIN OF STRENGTH

In compliance with the foreign practice of fixing the permissible stresses for longitudinal hull members subjected to the longitudinal bend, the 1958 edition of "Standards" prescribed different permissible stresses in the hulls of ships up to 100 m. in length, from 100 to 200 m. in length and, finally, 200 and more meters in length. Higher rated stresses were allocated to ships of a greater length. For all that the length of a calculated trochoidal wave was considered to be equal to the ship's length; and the height of the wave to be equal to $\frac{L}{30}+2$ for ships up to 120 m in length and $\frac{L}{20}$ for ships 120 m and more in length (with L standing for the sbip's length).

The data collected by different investigators show that the relative height of the wave decreases with the increase of its length; this circumstance predetermined the necessity of correcting the rated wave length to a height relationship that had previously been assumed to be directly proportional for ships above and below 120 m in length. On the grounds of supplementary analysis it is considered at present to be expedient to accept uniform standards for permissible stresses of a general strength irrespective of the ships' length. In connection with this, corresponding alterations in the estimation of the wave characteristics have been introduced.

In addition, researches are continued for the amendments of standards of permissible stresses for hull members taking part in the longitudinal and the local strengths of the ship.

THE WORKING OUT OF OTHER GUIDING INSTRUCTIONS FOR THE CALCULATION OF STRUCTURES OF MERCHANT VESSELS

Along with theoretical and experimental researches in the line of the ship's hull strength studies are also made of different instructions and of the guiding technical data on ship structure, which are from time to time amended and supplemented. Having regard to the fact that the strength and the reliability of structures are, to a considerable degree, dependent on the character of the interconnections of different structural members, the instructions contributing to a rational designing of welded hulls and recommendations for the designing of different hull structures are now worked out.

The reliable service of welded hulls can be ensured only by using material possessing certain desired qualities, such as weldability, plasticity and strength, resistance to brittle fractures under actual service conditions as well as the keeping of these properties after the termination of different operations connected with the technological process of construction. In order to establish the quantitative values of these properties and the methods of their assessment, the requirements to shipbuilding materials are constantly corrected to keep pace with the progress in the improvements of material. These requirements are based on the results of research works and experience gained in using weldable materials in shipbuilding, as well as on the study of new shipbuilding materials (light alloys in particular).

The results of theoretical and experimental research in the field of ship strength in the USSR found their reflection in the three volumes of the reference handbook on ship strength, published in 1958—1960. The results of some researches are published in the transactions of the Scientific Technical Society of Shipbuilding Industry, in the reports of specialized institutes and scientific papers of shipbuilding colleges.

Research in the field of strength and structure of ships are based on achievements in the theory of strength and in the applied theories of elasticity and plasticity in the USSR, taking into account the development of these sciences abroad.

During the past few years along with the achievements of sciences and technique in all branches of knowledge, the shipbuilding sciences have also made great strides ahead.

One of the problems of the Congress, as seen by the Soviet delegation, is the coordination of efforts in improving hull structures of merchant vessels. We have learned from the special literature already published, that strength tests of vessels when at sea are being carried out in a number of foreign countries. In these tests, as far as it is known, synchronous measurements of parameters of rolling and stresses of ship structures and parameters of external conditions which cause the rolling of the ship. Such tests provide vast statistical data, which are very useful for the amendments of the method of ship strength calculations.

Similar tests are being carried out in the USSR, and the results achieved are already being put into practical use for the benefit of all maritime countries.

If the experimental data available in many countries were to be pooled together, it would be possible to attain better results in solving problems connected with the external forces acting upon hulls under actual service conditions.

The above does not, however, give an exhaustive answer to all questions which would have been jointly solved according to a research program specially drawn up for this purpose and agreed upon by all concerned. We are, however, sure that the work to be done by the International Congress on the subject of ship structures and ship strength problems would be of great use for the progress of shipbuilding in all countries.

We hope that the participation of the Soviet delegation in the proceedings of the Congress may be taken as the first step on the way of a creative cooperation directed towards the solution of technical problems confronting shipbuilders in the whole world.

Издательство «Морской транспорт»

Типография им. Володарского. Зак. 2713. 9-IX-61 г.